The S-125 Neva

The S-125 Neva (SA-3) system was developed by the KB-1 bureau leaded by Raspeltin as well as the SA-75/S-75. This was the reason of the similarities between the SA-2 and SA-3 family, similar technical solutions were not coincidence.

The reason for developing of the S-125 Neva was the low level engagement limitation of the Dvina and Volhkov systems. Initially both had 3 km minimal engagement altitude thanks to later upgrades they achieved 300 then 100 meter minimal engagement altitude. The S-125 Neva was designed against low level targets but regardless of this basis it could be used against high flying targets either. The Neva batteries supported Dvina /Densa/Volkhov batteries, filled the low level gaps in engagement zone of SAM rings around the most important Soviet cities.

The general technical level and structure was only slightly different for Volkhov – the fire control cabin was very similar to Volhkov – we can say the S-125 Neva was the simplified and more user-friendly "descendant" of the SA-75/S-75 SAM family. The main differences comparing to Dvina and Volkhov are the followings:

- The antennas on the fire control radar (guidance station) are very similar to Dvina and Volkhov but they are aligned differently, tilted with 45 degree to reduce the amount of ground clutter reflection, see the drawing on the following page. In case of low level target tracking a big part of scan hits the ground while using the same elevation setting only a very small region of the overlapped scan area of the two antennas hit the ground.

- The Neva was able to perform only narrow beam and LORO modes it did not have such wide beam mode as Dvina. This meant weaker ARM launch detection capability as has been explained for S-75M Volkhov family even in AGM-45 era was inferior the Neva in this era only from tracked airplane could be detected the ARM separation.

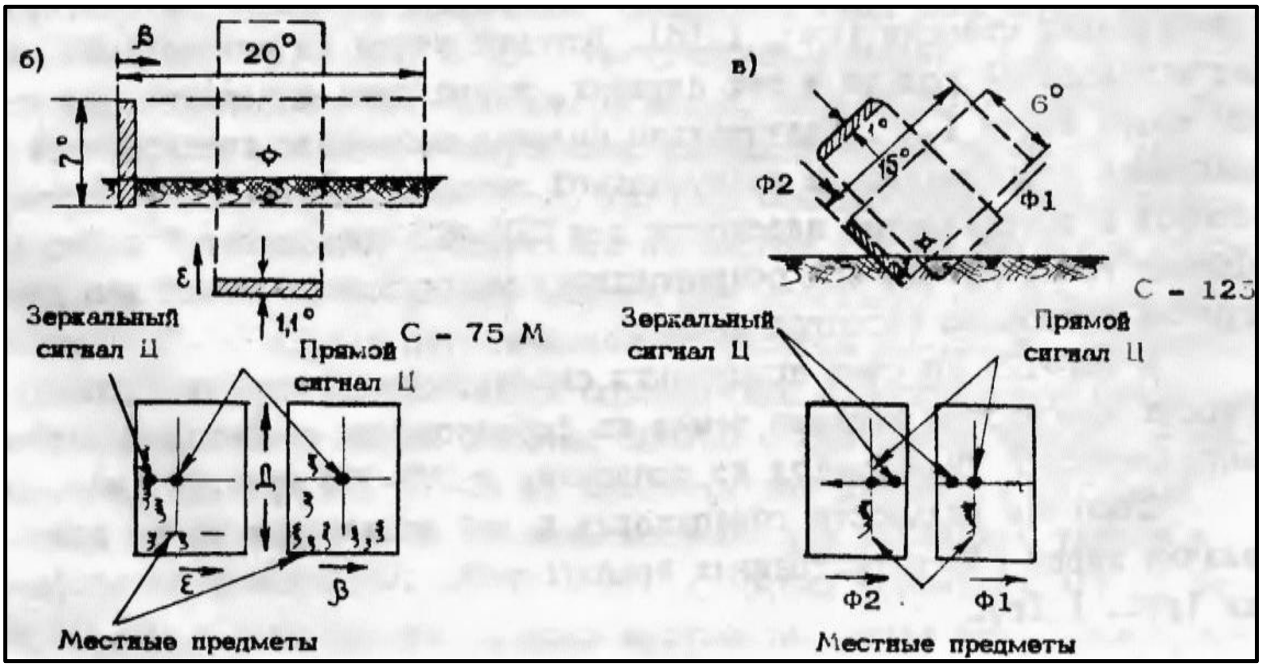
- Regardless the reduced quantity of launch rails from 6 to 4 the quantity of missiles per battery increased. The smaller and lighter missile (915-950 kg depending on missile variant comparing to 2000 kg+ weight of Dvina and Volkhov) made possible to mount 2 instead 1 missile. Later was developed a 4 missile capable launcher after experiences of local wars when became evident the quantity of missiles per battery has to be increased.

- The missile had two stages as well as the Dvina and Volkhov but both stages used solid propellant rocket engine which made much easier handling and working with the missis comparing to Dvina and Volkhov which used dual component very toxic and corrosive liquid fuel. It made easier the battery relocation because fuel had to be drained from missiles of SA-2 family, during this process the crew had to wear chemical protection suit. The equipment of a Neva battery was fewer because lack of fuel transport trucks.

- Dvina had 2 (electrical) feeder channels, Volkhov had 4 channels –these were hermetic, angular, arm size thick channels – while the Neva had only one. The mobility of Neva increased because all of listed differences above because decreased the deployment time.

- Instead of P-12/P-18 target acquisition (EW) radar Neva used the P-15 (Flat Face) or P-19 which were able to search with lower minimal altitude but with smaller range than P-12/18. Because of smaller missile kinematic range the less detection range was enough.

- Similar to Dvina and Volkhov Neva had only 1 target channel but instead of 3 missile channels had only 2, only two missiles could be guided in the same time on one target.



Above is the difference between antenna alignments of Dvina/Volkhov and Neva. [1]

The most important subvariants of S-125 were the followings:

- S-125 Neva (SA-3A) with V-600P 5V24 missile entered in service in 1961 in the Soviet Union. This variant had only dual missile capable launchers the minimal engagement altitude was 300 meters. Small quantity was exported from 1969 to Poland, Czechoslovakia, Egypt and Iraq.

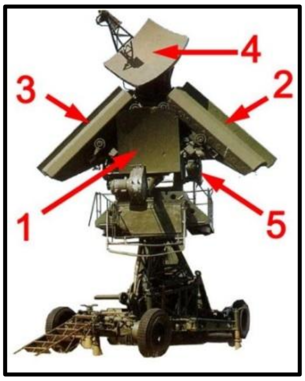
- S-125 Neva-M (SA-2B) with V601P 5V27U missile entered in service in 1970. This variant got the quadruple launcher and first from Neva family the Karat TV system for optical tracking (similar to Volkhov) applying solid state electronics instead vacuum tube technology also happened on this variant, the minimal engagement altitude improved to 50 meters. Neva-M was exported between 1973 and 1983.

- S-125M1A (SA-3B) with V601PD 5V27D missile entered in service in 1978. Minimal engagement distance was 3.5 km the minimal engagement altitude was 20 meter. The anti-jam GSN electronics package was applied on this version; the M1A variant was exported between 1983 and 1989.

The export variant outside of Warsaw Pact got the “Perchora” designation; see the exported quantity in the attachment. On the following page are the main parts of SNR-75, the fire control radar / guidance station

[1] *http://historykpvo.narod2.ru/*
Методические указания по подготовке зенитных ракетных войск к отражению ударов тактической и палубной авиации и крылатых ракет типаАЛКМ на предельно малых высотах.1979, page 8.

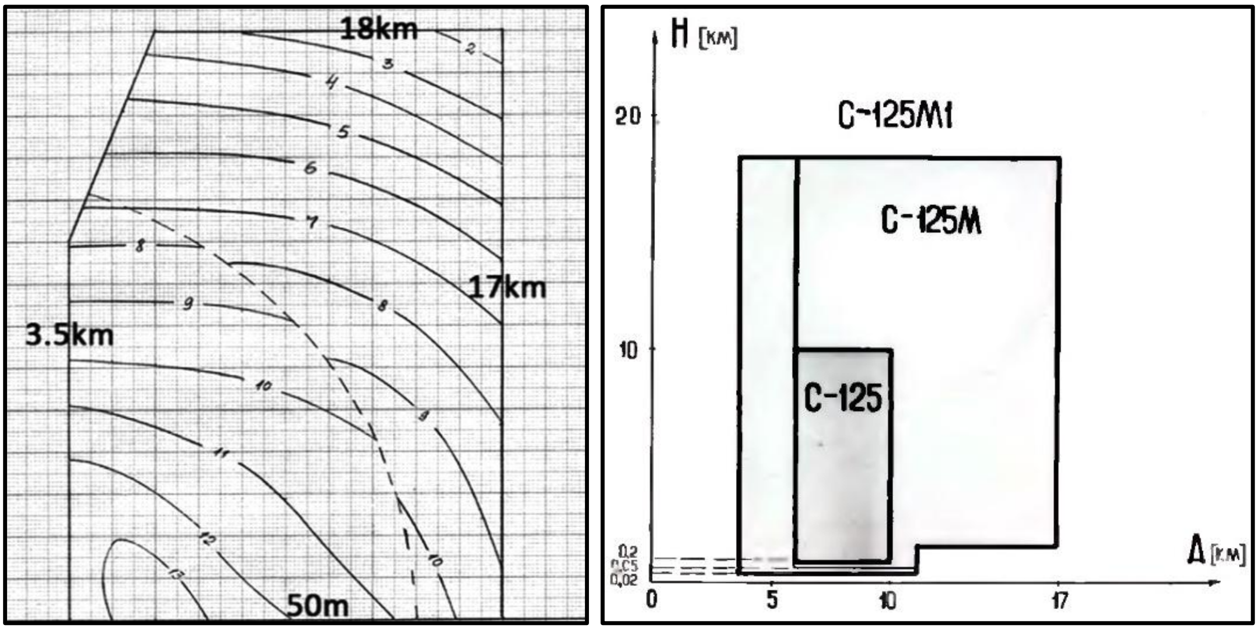
1. UV-10, 3 cm wavelength, narrow beam transmitter/receiver antenna.
2. UV-11, 3 cm wavelength, wide beam receiver antenna.
   (angle – F1)
3. UV-11, 3 cm wavelength, wide beam receiver antenna.
   (angle – F2)
4. UV-12, decimeter wavelength, missile command transmitter antenna.
5. 9Sh33A camera. (optical channel)



The Neva had the following missiles (only the main variants are the table below.)

SAM system type	*Cabin types*	*Missile*	*Missile range*	*Missile range*	*Target speed*
			km	*km*	*km/h (m/s)*
Sz-125 Neva (SA-3A)	RKU-N– power distribution cabin UNK – fire control cabin	V-600P 5V24	6-12	0,3-10	2000/560
Sz-125M1 Neva (SA-3B)	RKU-N– power distribution cabin UNK – fire control cabin	V-601P 5V27U V-601PD 5V27D	6-17 3,5-25*	0,05-18 0,02-18	2000/560 2500/700

***** Only against subsonic targets in passive terminal phase (after burnout of the engine), otherwise 17 km. The range values are slant range is all cases.***



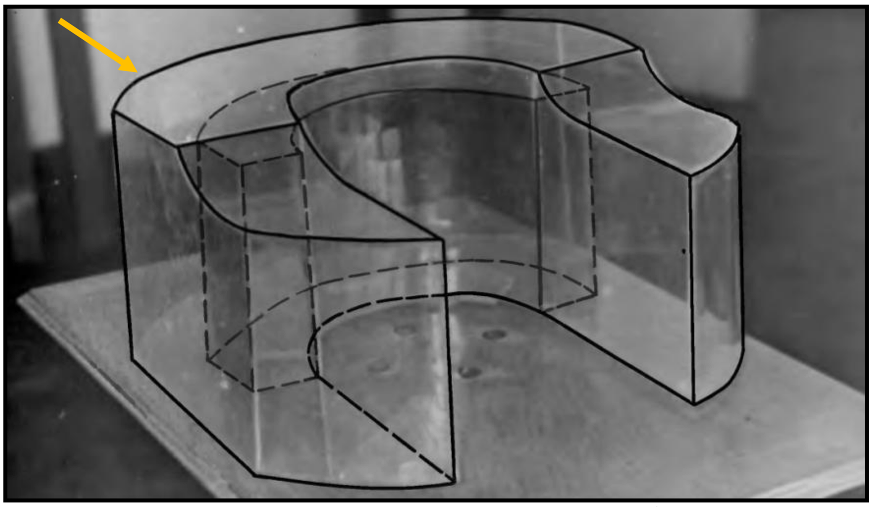
Above left is the available G load within the engagement zone,* [2] *above right is the engagement zone with without electronic jamming up to 300 m/s target speed. (Target offset distance is 0 km)

Comparing to Dvina or best Volkhov missile the maneuverability of missile was better below 8 km altitude 10-13G turn was possible, even the Volkhov M3 with V-759 5Ya23 had weaker turning capability; it was harder to dodge the missiles of Neva comparing the Vietnam era Dvina in active phase of the missile when rocket engine is still running. In the passive phase the maneuverability of the missile quickly decreases. The engagement zone of Neva is considerably smaller than Volkhov had but in general was within the active phase of the zone was superior comparing to Dvina or best Volkhov.

[2] *http://historykpvo.narod2.ru/ - Альбом разработок ЦКБ Алмаз 1947 - 1977 гг, page 7*

The most advanced variant of the Neva had 3.5 km minimal engagement range, minimal engagement altitude was 20 meter. The Neva-M and later variants were effective even against low level attack/strike airplanes which had terrain following radar and could fly even at night at 60 m – such as F-111 or Tornado – with trained crew. Against such fast and low flying targets both Dvina and Volkhov were ineffective.

On the previous page only a simple engagement envelope was shown but considering target speed and other parameters the engagement zone of the Neva is much more complex but even this more complicated image shows the engagement zone targets considering 300 m/s target speed or less. The yellow arrow shows the incoming target side.



The engagement zone of S-125M Neva. [3]

On the following engagement zone drawings the different colored arrows mean the followings:

- Yellow: Offset distance is 0 km.
- Pink: Offset distance is 10 km.
- Dashed pink: Regardless it has the same end point but extending the vector we can see this is the same case as first with yellow arrow, offset distance is 0 km.
- Red: It points on minimal engagement distance.
- Blue: It points on of minimal engagement distance lines at 14, 16 and 18 km altitude, the section view above the 72 degree line which can be seen of side view of the engagement envelope.
- Green: It points the minimal engagement distance in case of different altitude with three point guidance (ТТ) and with half-leading (ПС) method if the fire control radar has to turn the target which passing by the battery with certain offset distance.
- Solid lines show the maximal engagement zone of the Neva.

On left the diagram concerns non-maneuvering, non-jamming targets-below 300 m/s speed on the right with 300-700 m/s speed.

[3] http://historykpvo.narod2.ru/

Результаты работ по расширению возможностей ЗРК С-25,С-75,С-125 на полигоне вч 29139.Выставка 1964 г, page 59.

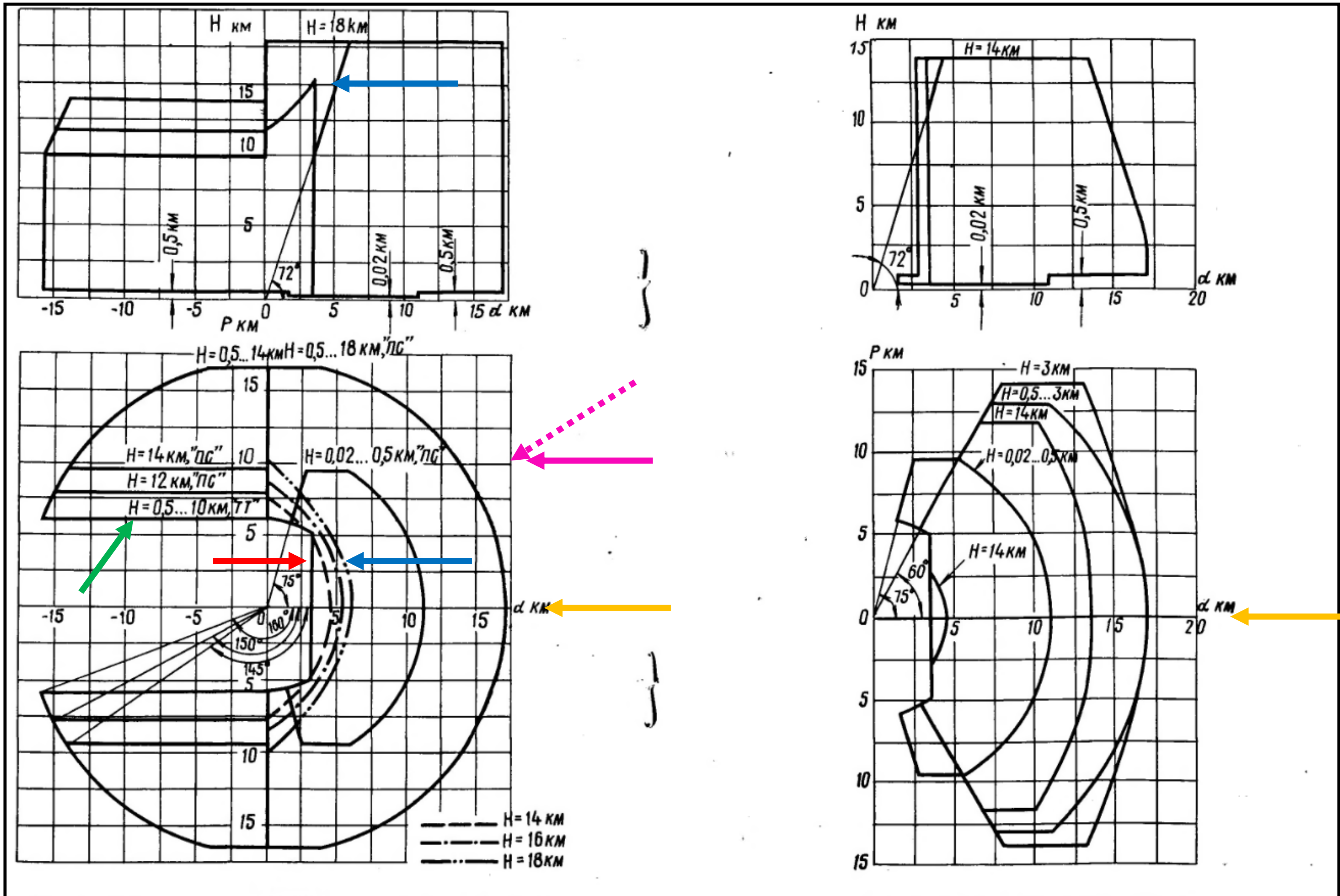


РИС. 1. СЕЧЕНИЯ ЗОН ПОРАЖЕНИЯ ПРИ СТРЕЛЬБЕ БЕЗ ПОМЕХ (РЛК, МЕТОДЫ "ПС" И "ТТ", V ≤ 300 М/С)

РИС. 2. СЕЧЕНИЯ ЗОН ПОРАЖЕНИЯ ПРИ СТРЕЛЬБЕ БЕЗ ПОМЕХ (РЛК, МЕТОД "ПС", 300 М/С < V ≤ 700 М/С)

Above are engagement zones of S-125M Neva with target speed <300 m/s on left and 300-700 m/s on right.[4]

[4] *Page 28, ПРАВИЛА СТРЕЛЬБЫ ЗЕНИТНМИ УПРАВЛЯЕМЫМИ РАКЕТАМИ СИСТЕМЫ С-125М, http://historykpvo.narod2.ru/*

Of course a Neva battery is more than just the radars, missile launch rails or cabins, a more detailed list of equipment of a single S-125 M1 battery is listed below. Some sources counts the PRV-10/11 height finder radar as part of battery but because of the reasons what have been mentioned for Dvina and Volkhov typically Neva batteries did not had height finder radar.

Main elements of the S-125M1 battery			
Item	***pcs.***	***function and name***	***vehicle***
SzNR-125 UNV cabin Low Blow	1	fire control radar	towed
SzNR-125 UNK cabin	1	fire control cabin	towed
5P71 /5P73	4	Launch rail with 2 pcs. / 4 pcs. missiles	towed
PR-14A/AM	8	missile transporter / loader	ZIL-131
5E96	1	generator	towed
AKKORD-125*	1	training emulator	towed
P-15/P-19 Flat Face		360 degree scan target acquisition radar	Ural-375
1L22 Parol 4 or 75E6 Parol 3	1	IFF interrogator unit	KrAZ-255
5Ya61/62/63 Tsikloida	1	radio relay van for automatized command post	towed

*** Not all batteries had emulator, one regiment or brigade had one and could be assigned to one battery according to training plan.**

Similar to Dvina and Volkhov batteries Neva could be used on filed and as well as using fortified battery posts the typical deployment layout made easily recognizable the site.

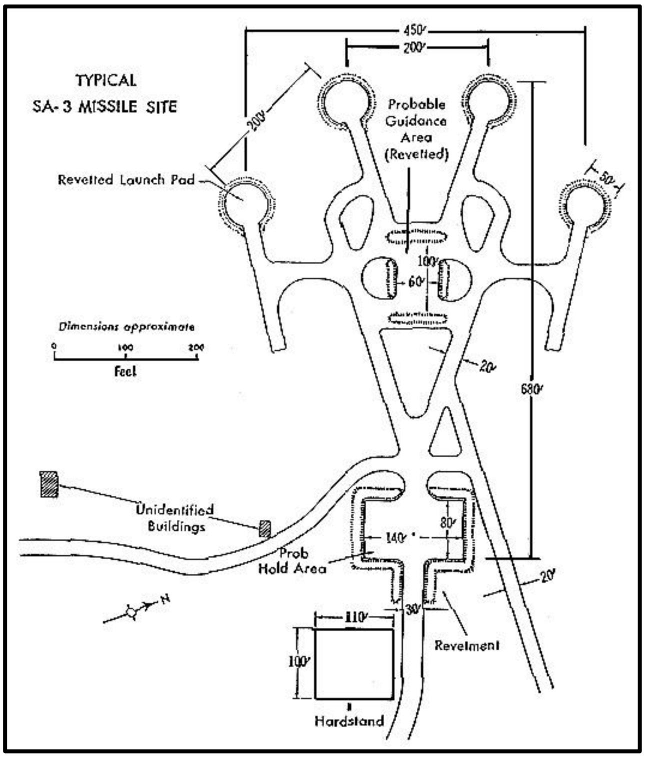


Above is a Neva battery in Middle East. The battery had only 3 missiles rails – very likely one destroyed previously – in the middle are the SNR-125 UNV and UNK cabins (red arrow.)

The S-125 did not participate in Vietnam naval ports of North Vietnam were mined by the US the only way transporting heavy equipment to North Vietnam was possible on railway through China. The leadership did not want to take risk that new and best SAM systems “by accident” fall into hands of China. The

Vietnamese crew got the training and passed the live fire exam in the Soviet Union but batteries were not shipped into Vietnam.

Form the '70s the Neva involved may wars and interwar "incidents" [5] in the Middle East between Israel and Arab countries, Iraq used against Iran (1980-88) and the Coalition in 1991 during the Operation Desert Storm, Libya against US jets (El Dorado Canyon) and Serbia in 1999 during the Allied Force where Neva got the most famous "scalp" an F-117 was downed. This success resulted many urban legends and myths about the case as well as over estimation the capability of old Soviet SAM systems and underestimation of stealth capability. (In another chapter is explained this case.) After end of Cold War most of operator countries retired Neva similar to S-75M Volkhov.





Above left is a typical Neva SAM site, above right is the P-15 Flat Face target acquisition (EW) radar.




Above left is the quadruple 5P73 launch rail; on right is the dual 5P71 launch rail.

Finally – as usual – here are some gallery and video links about the Neva SAM family.
http://www.ausairpower.net/APA-S-125-Neva.html
https://www.youtube.com/watch?v=vuIcJl08sXs
https://www.youtube.com/watch?v=c5zC_JWvxVU

[5] *https://en.wikipedia.org/wiki/War_of_Attrition*